

What is claimed is:

1. (New) A bump forming apparatus comprising:

a bonding stage for supporting a semiconductor wafer and for heating the semiconductor wafer to a temperature for forming bumps on electrodes on a circuit of the semiconductor wafer;

a bump forming head for forming the bumps on the electrodes of the semiconductor wafer;

a load and transfer device for placing the semiconductor wafer on and removing the semiconductor wafer from said bonding stage; and

a controller for operating said bonding stage and said load and transfer device so as to perform a post-heating operation on the semiconductor wafer after the bumps are formed on the semiconductor wafer to thereby control a temperature drop of the semiconductor wafer, said controller being operable to control the post-heating operation on the semiconductor wafer by controlling said load and transfer device and said bonding stage so that the semiconductor wafer is positioned by said load and transfer device at a cooling position above said bonding stage while said bonding stage is heated to the temperature for forming the bumps such that the semiconductor wafer does not contact said bonding stage when in the cooling position.

2. (New) The bump forming apparatus of claim 1, wherein said controller is operable to control the post-heating operation on the semiconductor wafer by controlling said load and transfer device and said bonding stage so as to change at least one of a gap size between said bonding stage and the semiconductor wafer when the semiconductor wafer is positioned in the cooling position by said load and transfer device, and a period of time during which the semiconductor wafer is positioned at the cooling position above the bonding stage by said load and transfer device.

3. (New) The bump forming apparatus of claim 2, wherein said controller is operable to control the post-heating operation on the semiconductor wafer by controlling said load and transfer device and said bonding stage so as to change at least one of the gap size and the period of time multiple times.

4. (New) The bump forming apparatus of claim 1, wherein said controller is operable to control the post-heating operation in accordance with a preliminarily set program for post-heating.

5. (New) The bump forming apparatus of claim 1, further comprising a temperature measuring device for measuring a temperature of the semiconductor wafer subjected to the post-heating operation, said controller being operable to control the post-heating operation based on the temperature of the semiconductor wafer measured by said temperature measuring device.

6. (New) The bump forming apparatus of claim 1, wherein said controller is operable to control the post-heating operation based on at least one of a material of the semiconductor wafer and a thickness of the semiconductor wafer.

7. (New) The bump forming apparatus of claim 1, wherein said load and transfer device includes clamp mechanisms spaced equally apart to prevent a dynamic stress and a thermal temperature gradient on the semiconductor wafer.

8. (New) The bump forming apparatus of claim 1, wherein said controller is further operable to control said bonding stage and said load and transfer device so as to perform a preheating operation on the semiconductor wafer before the semiconductor wafer is placed on said bonding stage and heated to the temperature for forming bumps.

9. (New) The bump forming apparatus of claim 1, wherein said controller comprises a first controller, further comprising a second controller for operating said bonding stage and said load and transfer device so as to perform a preheating operation on the semiconductor wafer before the semiconductor wafer is placed on said bonding stage and heated to the temperature for forming bumps, said second controller being operable to control the preheating operation on the semiconductor wafer by controlling said load and transfer device and said bonding stage so that the semiconductor wafer is positioned by said load and transfer device at a preheating position above said bonding stage while said bonding stage is heated to the temperature for forming the bumps such that the semiconductor wafer does not contact said bonding stage when in the

preheating position.

10. (New) The bump forming apparatus of claim 9, wherein said second controller is operable to control the preheating operation on the semiconductor wafer by controlling said load and transfer device and said bonding stage so as to change at least one of a gap size between said bonding stage and the semiconductor wafer when the semiconductor wafer is positioned in the preheating position by said load and transfer device, and a period of time during which the semiconductor wafer is positioned at the preheating position above the bonding stage by said load and transfer device.

11. (New) The bump forming apparatus of claim 10, wherein said second controller is operable to control the preheating operation on the semiconductor wafer by controlling said load and transfer device and said bonding stage so as to change at least one of the gap size and the period of time multiple times.

12. (New) The bump forming apparatus of claim 9, wherein said second controller is operable to control the preheating operation in accordance with a preliminarily set program for preheating.

13. (New) The bump forming apparatus of claim 9, further comprising a temperature measuring device for measuring a temperature of the semiconductor wafer subjected to the preheating operation, said second controller being operable to control the preheating operation based on the temperature of the semiconductor wafer measured by said temperature measuring device.

14. (New) The bump forming apparatus of claim 9, wherein said second controller is operable to control the preheating operation based on at least one of a material of the semiconductor wafer and a thickness of the semiconductor wafer.

15. (New) The bump forming apparatus of claim 9, wherein said load and transfer device includes a member for covering the semiconductor wafer when at least one of the

preheating operation and the post-heating operation is performed on the semiconductor wafer, said member having an opening for allowing heat to enter into said load and transfer device from said bonding stage.

16. (New) The bump forming apparatus of claim 15, wherein said load and transfer device further includes a heat insulation assisting device for blowing a temperature-controlled gas onto the semiconductor wafer covered by said member so as to provide heat insulation of the semiconductor wafer.

17. (New) The bump forming apparatus of claim 1, further comprising a storage container for storing semiconductor wafers, and further comprising a transfer device for transferring the semiconductor wafer to said storage container, and for transferring the semiconductor wafers to and from said load and transfer device.

18. (New) The bump forming apparatus of claim 17, further comprising at least one of:
a first temporary holding member for holding the semiconductor wafer without bumps formed thereon; and
a second temporary holding member for holding the semiconductor wafer with bumps formed thereon.

19. (New) The bump forming apparatus of claim 18, further comprising said first temporary holding member and said second temporary holding member, said load and transfer device including:

a first transfer device for transferring the semiconductor wafer held by said first temporary holding member to said bonding stage; and

a second transfer device for transferring the semiconductor wafer from said bonding stage to said second temporary holding member.

20. (New) The bump forming apparatus of claim 17, wherein said storage container comprises a first storage container for storing semiconductor wafers without bumps formed thereon, and comprises a second storage container for storing semiconductor wafers with bumps

formed thereon.

21. (New) The bump forming apparatus of claim 20, wherein said transfer device includes a carry-in device for transferring the semiconductor wafer without bumps from said first storage container, and includes a carry-out device for transferring the semiconductor wafer with bumps to said second storage container.

22. (New) The bump forming apparatus of claim 21, wherein said carry-out device has a blower for supplying a temperature-controlled gas to the loaded semiconductor wafer with bumps, said controller being operable to control a temperature of the gas supplied by said blower.

23. (New) The bump forming apparatus of claim 22, wherein the gas supplied by said blower comprises an inert gas.

24. (New) The bump forming apparatus of claim 22, wherein the gas supplied by said blower comprises nitrogen gas.

25. (New) The bump forming apparatus of claim 17, wherein said transfer device includes a loading member for loading the semiconductor wafer, at least a portion of said loading member for contacting the semiconductor wafer having a thermal insulating material formed thereon.

26. (New) The bump forming apparatus of claim 1, further comprising a wafer temperature control device for controlling a temperature difference between a temperature at a bonding stage-contact face of the semiconductor wafer and a temperature at a circuit formation face of the semiconductor wafer opposite to the bonding stage-contact face before the bump formation is performed and after the semiconductor wafer is positioned on said bonding stage, said wafer temperature control device being operable to control the temperature difference to be within a warpage non-generation temperature difference range so that a warpage of the semiconductor wafer is restricted to a level not obstructing the bump formation.

27. (New) The bump forming apparatus of claim 26, wherein said wafer temperature control device is operable to control the temperature difference by heating the circuit formation face of the semiconductor wafer placed on said bonding stage.

28. (New) The bump forming apparatus of claim 27, wherein said wafer temperature control device is operable to heat the circuit formation face by supplying heating air to the circuit formation face of the semiconductor wafer, the heating air having a temperature for maintaining the temperature difference within the warpage non-generation temperature difference range.

29. (New) The bump forming apparatus of claim 26, wherein said wafer temperature control device is operable to control the temperature difference by cooling the bonding stage-contact face of the semiconductor wafer placed on said bonding stage.

30. (New) The bump forming apparatus of claim 29, wherein said wafer temperature control device is operable to cool the bonding stage-contact face by supplying cooling air to the bonding stage-contact face of the semiconductor wafer, the cooling air having a temperature for maintaining the temperature difference within the warpage non-generation temperature difference range.

31. (New) The bump forming apparatus of claim 26, wherein said wafer temperature control device is operable to maintain the temperature difference within a warpage non-generation temperature difference range of 20°C.

32. (New) The bump forming apparatus of claim 26, wherein the semiconductor wafer comprises a quartz-based wafer.